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[54] **REFRIGERANT SYSTEM EXPANSION MEANS**
7 Claims, 1 Drawing Fig.

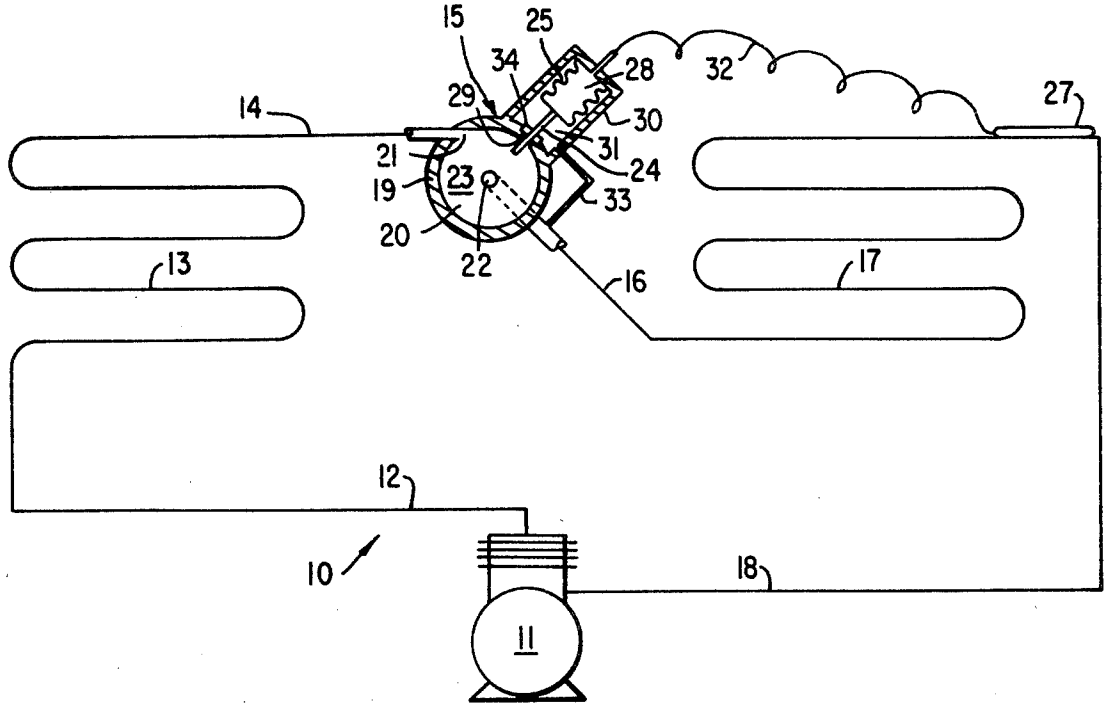
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[50] **Field of Search** 137/81.5; 62/225, 160, 197, 471, 500

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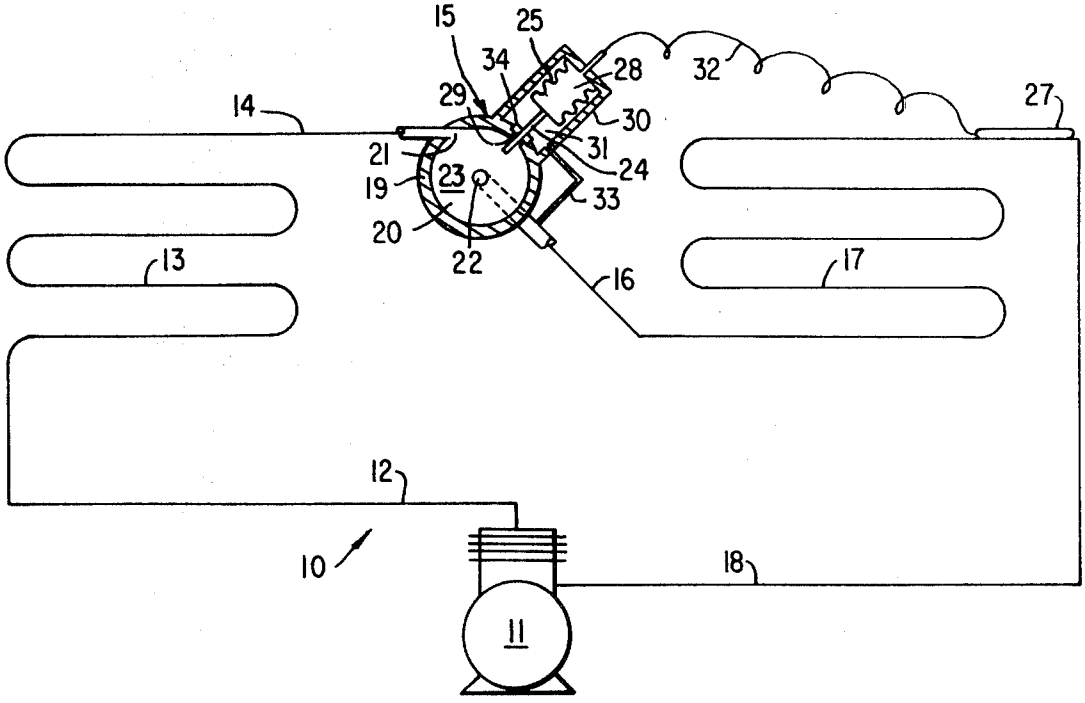
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ABSTRACT: A refrigerant expansion or metering device employed in refrigeration systems including compression means, a first heat exchanger and a second heat exchanger, comprising a fluid regulator forming a vortex chamber, through which refrigerant is passed. Disposed within the vortex chamber is movable means operable to vary the path of flow and to vary the rate of flow of refrigerant through the vortex chamber. Control means vary the position of the movable means in response to changes in temperature in the refrigeration system.



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REFRIGERANT SYSTEM EXPANSION MEANS

BACKGROUND OF THE INVENTION

This invention relates to refrigeration systems and more particularly, to an improved expansion means for refrigeration systems.

Refrigeration systems employ, as a means for expanding the relatively high-pressure liquid refrigerant leaving the system condenser, either a fixed restrictor, commonly known as a capillary tube, or a variable restrictor, such as a thermal expansion valve. While fixed restrictors are relatively inexpensive, their lack of adaptability to change in system load limits their usefulness. On the other hand, the variable restrictor, such as a thermal expansion valve, incorporates a controlling mechanism for varying the valve setting in response to changes in refrigerant temperature exiting from the evaporator due to variations in load conditions in the system. However, variable restrictors are relatively expensive and are generally the subject of numerous repairs.

The invention herein disclosed relates to a novel expansion device, one that is relatively inexpensive to manufacture and relatively maintenance free, and one that is adaptable to changes of temperature of the refrigerant exiting from the evaporator.

SUMMARY OF THE INVENTION

The invention herein disclosed may be employed in a refrigeration system including compression means, a first heat exchanger for receiving refrigerant discharged by the compression means, and a second heat exchanger connected to the suction side of the compression means. The invention herein disclosed communicates the first heat exchanger with the second heat exchanger. Relatively high-pressure liquid refrigerant flows from the first heat exchanger through the invention functioning as the system refrigerant expansion device. The refrigerant leaves the invention as a relatively low-pressure mixture of liquid and gas.

The refrigerant expansion device includes a fluid regulator forming a vortex chamber through which the refrigerant passes en route to the second heat exchanger. The refrigerant inlet in the chamber is in substantially tangential communication therewith. The refrigerant passing through the chamber undergoes an approximate 90° change in direction.

Disposed in the chamber, transverse to the path of flow of the refrigerant, is a movable means, such as a plunger. Control means, operable to selectively withdraw the movable means from the chamber or project the movable means further into the chamber, functions in accordance with changes in the temperature of the refrigerant exiting from the second heat exchanger. When the plunger is substantially withdrawn from the chamber, the vortex effect on the refrigerant flow is at its maximum, the refrigerant flow through the chamber being greatly impeded. As the plunger is projected in the chamber, the vortex effect is reduced, the refrigerant flow through the chamber being thereby increased.

BRIEF DESCRIPTION OF THE DRAWING

The single FIGURE of the drawing is a schematic view, partially in section, of a refrigeration system incorporating the novel refrigeration expansion means.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the single FIGURE of the drawing, there is shown a refrigeration system **10** employing the novel refrigeration expansion device **15** herein disclosed. The refrigeration system **10** is typical of the type used with air-conditioning units, such as a room air conditioner. Refrigeration system **10** has a suitable refrigerant compressor **11** which, while illustrated as a reciprocating compressor, may comprise any suitable compressor such as a rotary, centrifugal, etc. Refrigerant line **12** conducts the relatively high-pressure gaseous refrigerant discharged from compressor **11** to a first heat exchanger **13**, functioning as the system condenser.

The high-pressure, gaseous refrigerant condenses in the first heat exchanger **13** by therethrough in heat transfer relationship with a relatively cold medium such as air. The liquid refrigerant formed thereby passes to the system expansion or metering means **15** via conduit **14**.

Expansion device **15** reduces the pressure of the liquid refrigerant and controls the flow thereof to the remaining portion of the system. A detailed discussion of the novel expansion device **15** will be found hereinafter.

The reduced pressure liquid refrigerant is fed via line **16** to a second heat exchanger **17** functioning as the system evaporator. The thermal interchange effected by evaporator **17** between the refrigerant and the medium being cooled, for example air, vaporizes or evaporates refrigerant while extracting heat from the medium being cooled. A suitable circulating means such as a fan (not shown) may be provided for bringing the medium being cooled into heat transfer relation with the refrigerant in the evaporator **17**. Vaporized refrigerant leaving evaporator **17** returns through line **18** to the inlet or suction side of the compressor **11**.

The refrigerant expansion or metering means **15** disclosed herein is a vortex-type fluid regulator. The regulator comprises a shell **19** forming a generally cylindrical vortex chamber **20**. Refrigerant line **14**, which connects to inlet **21** in the peripheral wall of shell **19**, discharges during system operation a stream of liquid refrigerant into vortex chamber **20**. Inlet **21** is in substantially tangential communication with chamber **20**. Outlet **22** in end wall **23** of the regulator communicates with refrigerant line **16**. As is manifest, refrigerant entering vortex chamber **20** undergoes an approximate 90° change in direction for discharge through outlet **22** into line **16**.

Movably disposed in the chamber **20**, transverse to the flow path of the refrigerant, is obstruction means **24** such as a rod or plunger. The purpose of obstruction means **24** is to vary the vortex effect created in chamber **20** and hence vary the discharge of refrigerant to line **16**, thence to evaporator **17**. Control means associated with movable obstruction means **24** acts to selectively withdraw or project the movable means **24** from or into chamber **20** in response to changes in temperatures of the refrigerant exiting from the evaporator **17**. As movable means **24** is projected further into chamber **20**, the vortex effect on the refrigerant flow is lessened; movable obstruction means **24** reduces the restrictive effect of a vortex flow path. Conversely, the further movable means is withdrawn from chamber **20**, the greater is the vortex effect on the refrigerant flow. Thus, at peak cooling loads, it is desirable for obstruction means **24** to extend fully into chamber **20**, while at minimal cooling loads on the system, it is desirable for the means **24** to be substantially completely withdrawn from the chamber **20** and thus the refrigerant flow therethrough is greatly impeded as desired.

The control means employed with the preferred embodiment of the novel refrigerant expansion device includes an expandable bellows **25** connected to movable means **24**. The bellows **25** is disposed in a housing **30**, preferably formed integrally with shell **19**. The inner surface of the wall of the bellows **25** defines a chamber **28** containing a charge of refrigerant, such as R-22. The outer surface of the wall of the bellows **25** and the inner surface of the housing **30** define a chamber **31**. Obstruction means **24** movably disposed within chamber **31** extends therefrom into chamber **20** via passageway **29** formed in the wall of shell **19**. Sealing means **34** is employed to prevent an appreciable quantity of refrigerant from flowing to chamber **31** from chamber **20**.

Communicating refrigerant line **16** to chamber **31** is conduit **33**. Conduit **33** passes part of the refrigerant exiting from the refrigerant expansion device **15** to chamber **31**, thus substantially filling the chamber **31** with refrigerant. The pressure of the refrigerant in chamber **31** exerts a compressive force on the bellows, thereby acting to withdraw movable means **24**

from chamber 20. Acting in conjunction with the force developed by the refrigerant in chamber 31 is the inherent compressive force of the bellows 25. Acting in opposition to these two forces is the force developed by the refrigerant in chamber 28, acting to expand the bellows and thus to project movable means 24 further into chamber 20.

Connected to bellows 25 via capillary tube 32 is feeler bulb 27, arranged to respond to the temperature of the refrigerant exiting from the evaporator 17. Preferably, bulb 27 is attached to the system suction line 18. A charge of refrigerant is contained in the bulb 27.

As the temperature of the refrigerant exiting from the evaporator 17 increases, the temperature and pressure of the refrigerant charge contained in bulb 27 correspondingly increases. The increase in pressure is transmitted via capillary tube 32 to the refrigerant charge contained in bellows 25, thereby affording a corresponding increase in the pressure of the refrigerant contained in chamber 28. The pressurized refrigerant vapor thence exerts a force greater than the compressive force of the bellows and the force developed by the refrigerant contained in chamber 31, thereby acting to expand the bellows 25. The expanding bellows 25 projects movable member 24 further into chamber 20, thereby increasing the flow of refrigerant to evaporator 17 as desired.

Conversely, if the temperature of the refrigerant exiting from the evaporator 17 decreases, the resulting force acting on bellows 25 will compress the bellows, and thus will reduce the amount movable member 24 projects into chamber 20. The flow of refrigerant to evaporator 17 will thereby be decreased as desired.

It should be understood, other methods of controlling the movement of means 24 may be utilized. In addition, the compressive force of the bellows may be made adjustable, to vary the superheat control in a manner well known to those skilled in the art.

The novel expansion device is relatively inexpensive to manufacture and is relatively maintenance free. In addition, the device will be adaptable to changes in refrigerant temperature exiting from the evaporator to obtain optimum heat transfer performance from the evaporator, and in addition, will prevent possible damage to the compressor by liquid refrigerant entering the suction side of the compressor.

While I have described and illustrated a preferred embodiment of my invention, it will be understood that my invention is not limited thereto, but may be otherwise embodied within the scope of the following claims.

I claim:

1. A refrigeration system comprising compression means, a first heat exchanger for receiving refrigerant discharged by said compression means; refrigerant metering means connected with said first heat exchanger; and a second heat exchanger arranged between said refrigerant metering means and said compression means, said components being connected to form a refrigerant flow cycle, said refrigerant metering means including:

A. a fluid regulator forming a vortex chamber through which refrigerant passes en route to said second heat exchanger, said vortex chamber having plunger means movably disposed therein; and

B. control means to vary the position of said plunger means in said vortex chamber, in response to the temperature of refrigerant exiting from said second heat exchanger, to vary the path of flow and to vary the rate of flow of said refrigerant through said vortex chamber in accordance with changes in system cooling load.

2. A refrigeration system in accordance with claim 1 wherein said control means includes:

A. a bellows having a refrigerant charge contained therein operably connected to said plunger means; and

B. means operable to sense the temperature of said refrigerant leaving said second heat exchanger, said means being further operable to increase the pressure of said refrigerant charge in said bellows as the temperature of the refrigerant leaving the second heat exchanger increases to move said plunger means further into said vortex chamber and to decrease the pressure of said refrigerant charge in said bellows as the temperature of the refrigerant leaving the second heat exchanger decreases to withdraw said plunger means from said vortex chamber.

3. A refrigerant-metering device employed in refrigeration systems operable to expand relatively high-pressure liquid refrigerant comprising:

A. a fluid regulator forming a vortex chamber through which refrigerant is passed;

B. refrigerant inlet means into said vortex chamber;

C. refrigerant outlet means from said vortex chamber;

D. plunger means movably disposed in said vortex chamber to vary the flow path of refrigerant therethrough; and

E. control means operable to vary the position of said plunger means in said vortex chamber in response to predetermined refrigeration system conditions, to vary the path of flow and to vary the rate of flow of said refrigerant through said vortex chamber in accordance with changes in said system conditions.

4. A refrigerant metering device in accordance with claim 3 wherein said refrigerant inlet means is in substantially tangential communication with said vortex chamber.

5. A refrigerant metering device in accordance with claim 3 wherein said refrigerant passing through said vortex chamber undergoes an approximate 90° change in direction from entering said chamber at said inlet means to leaving said chamber at said outlet means.

6. A refrigerant-metering device in accordance with claim 3 wherein said control means include:

A. a bellows having a refrigerant charge contained therein, operably connected to said plunger means; and

B. means operable to sense the temperature of refrigerant in one portion of said refrigeration system, said means being further operable to increase the pressure of said refrigerant charge in said bellows as the temperature of the sensed refrigerant increases, to move said plunger means further into said vortex chamber; and to decrease the pressure of said refrigerant charge in said bellows as the sensed refrigerant temperature decreases to withdraw said plunger means from said vortex chamber.

7. A method of regulating the flow of refrigerant in a refrigeration system comprising compression means, a first heat exchanger and a second heat exchanger comprising the steps of:

A. energizing said compression means to circulate said refrigerant through said system;

B. directing the flow of refrigerant from the first heat exchanger to the second heat exchanger through a path including a vortex;

C. withdrawing mechanical flow obstruction means, disposed within said vortex in the path of refrigerant flow, to restrict the flow of refrigerant from the first heat exchanger to said second heat exchanger as the cooling load on said system increases; and

D. projecting said mechanical obstruction means, disposed within said vortex chamber in the path of refrigerant flow, to increase the flow of refrigerant from the first heat exchanger to said second heat exchanger as the cooling load on said system increases.